Technical Specifications

for

High Voltage LED Lamp Driver

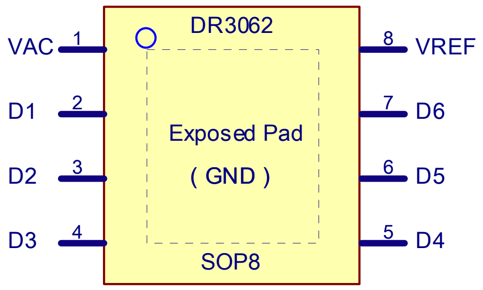
DR3062

Rev: 3.2A

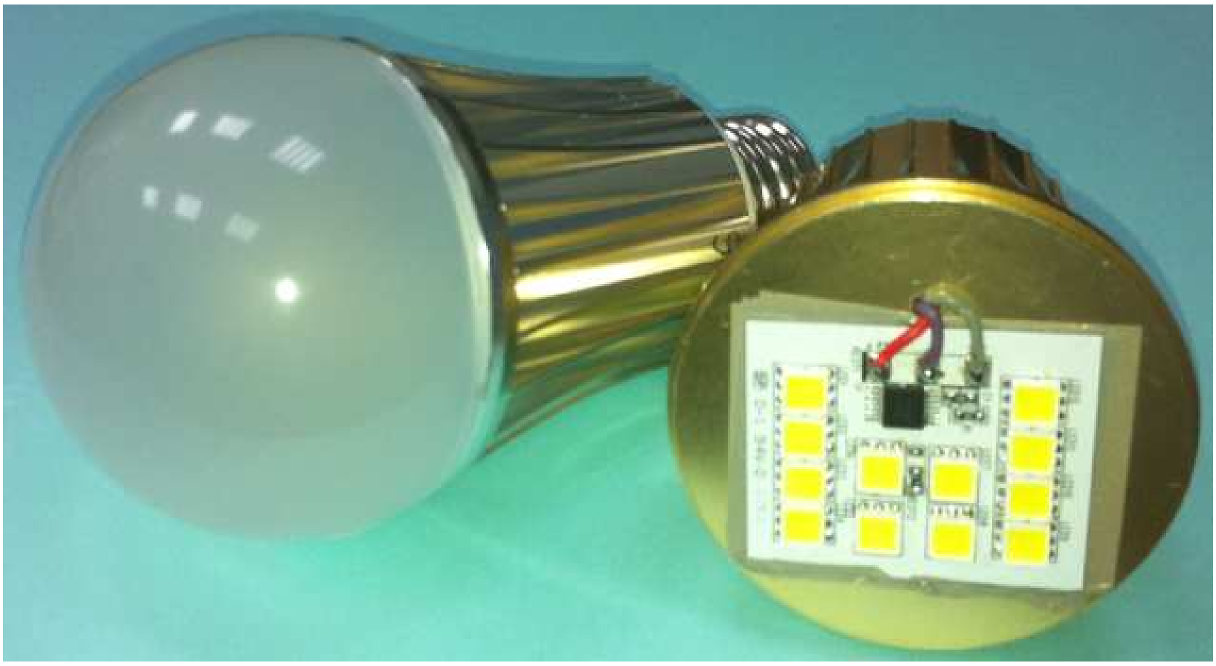
2012 / 02 / 06

Product Descriptions

Conventional solutions for LED lighting have some disadvantages such as : (1). Using high current high power LED results in high cost on LED's heatsink , (2). Using bulky transformers occupies considerable PCB space, (3). Using high-voltage electrolytic capacitors yields a short product life due to the aging characteristics of electrolytic capacitors. To cope with the above mentioned problems, ICTI came up with a patented solution without using high-voltage electrolytic capacitors, bulky transformers and high-current LEDs. This solution can greatly reduce the number of external components and save a lot of PCB space.



Top-View of SOP-8 Package



Functional Block Diagram

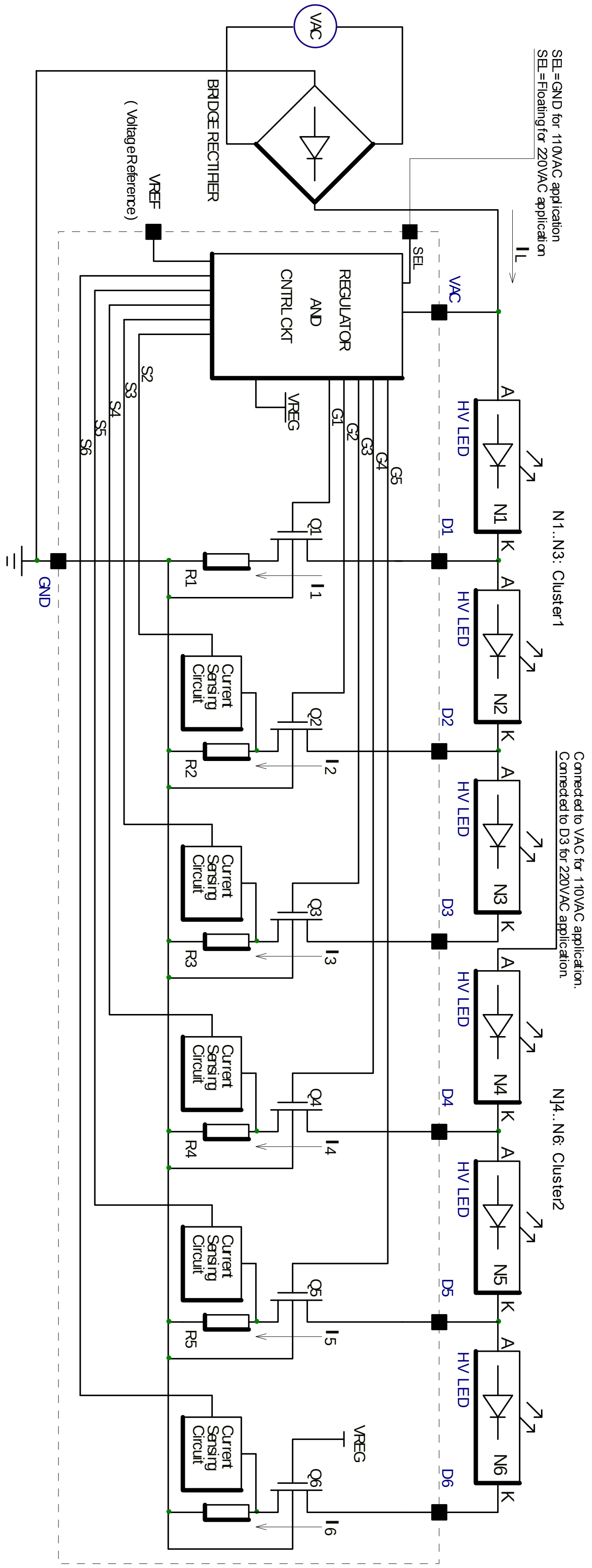


Figure 1: Functional block diagram

Pin Definitions

Pin Name	Descriptions	Pin number	
		SOP8-110	SOP8-220
VAC	Rectified AC Power	1	1
GND	Power and Signal Return	Exposed Thermal Pad (bottom)	Exposed Thermal Pad (bottom)
SEL	Bonding option • Connected to GND for 110VAC application. • Floating for 220VAC application.	Internally connected to GND	Internally un-connected
VREF	External Reference Voltage Globally sets the driving currents	8	8
D1	1st driver/220VAC (1st driver of cluster1 / 110VAC)	2	2
D2	2nd driver/220VAC (2nd driver of cluster1 /110VAC)	3	3
D3	3rd driver/220VAC (3rd driver of cluster1 /110VAC)	4	4
D4	4th driver/220VAC (1st driver of cluster2 /10VAC)	5	5
D5	5th driver/220VAC (2nd driver of cluster2 /110VAC)	6	6
D6	6th driver/220VAC (3rd driver of cluster2 /110VAC)	7	7

Maximum Rating

Ta=25℃, unless otherwise specified

Parameter	Description	Min	Max	Unit
Storage temperature		-40	125	℃
Operating temperature		-40	125	℃
Operating voltage	50 / 60Hz	-	350	Vrms
Leakage current (D1 ~ D6)	VREF = 0V, V(D1..D6) = 40VDC	-	0.1	uA
Sustained voltage (D1 ~ D6)	VREF = 0V	-	500	Volt
Driving capability (D1 ~ D6)	Instantaneous power (transient voltage x transient current)	-	4.0	Walt
	Average power	-	0.4	Walt
External reference voltage (VREF)	DC voltage	-0.3	20	Volt
Operation mode select (SEL)		-0.3	9	Volt
Thermal resistance (RθJA)	SOP8 Package	35	-	℃/W
Electro-Static Discharge (ESD)	human body mode	+/-1200V, Class 1C		
	machine mode	+/-300V, Class M3		
Surge test	at the phase of 90°	500	-	Volt
Latch-up	> 150mA)	Class I, Level A		

Electrical Characteristics

Test conditions: Ta=25℃, VAC=220VAC (rectified), u nless otherwise specified.

Parameter	Symbol	Description	Min	Typ	Max	Unit
Supply voltage (after rectification)	VAC	220VAC application (SEL=floating) [1] [2]	0	220	280	Vrms
		110VAC application (SEL=GND) [1] [2]	0	110	150	Vrms
Supply current	IDC	V(VAC) = 40VDC, VREF=18VDC	-	0.1	0.2	mA
Driving current	ID1	VREF = 18VDC	16	18	20	mA
	ID2~6	VREF =18VDC	32	36	40	mA
Temperature coefficient	TC	VREF =18VDC	-	-0.3	-	%/℃
Leakage current	Ileak	VREF = 0VDC, V(D1~ D6) =40VDC	-	-	0.1	uA
Input impedance of VREF terminal	ZIN		100	-	-	MΩ
Over voltage protection	VOVP	Terminal voltage of D6 [3]	100	120	140	Volt
Over voltage response time	tOVP		-	-	0.1	uS
Threshold of current sensing circuit	ISW		-	10	-	mA

Theory of Operation

The high voltage LED lamp driver, DR3062, has six current limiting drivers from D1 to D6, in which D2 to D6 has an associated current sensing circuit. For 220VAC application, if the current flowing through D2 is detected, D1 driver will be turned off; if the current flowing through D3 is detected, D1, D2 will be turned off; if the current flowing through D4 is detected, D1, D2, D3 will be turned off; if the current flowing through D5 is detected, D1, D2, D3 and D4 will be turned off; if the current flowing through D6 is detected, D1, D2, D3, D4 and D5 will be turned off. For 110VAC application, if the current flowing through D2/D5 is detected, D1/D4 driver will be turned off; if the current flowing through D3/D6 is detected, D1/D3, D2/D4 will be turned off; The above mentioned turn-on-off sequence is implemented by a logic control circuit. The current limiting driver and its associated current sensing circuit are shown in Figure 2; the timing diagram of the logic control circuit is shown in Figures 3 and 4.

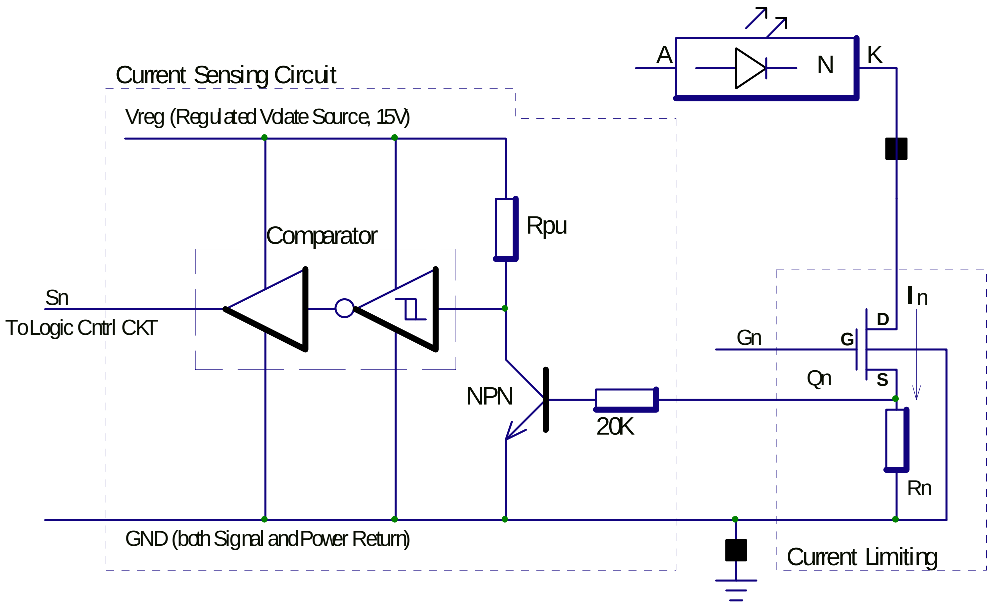


Figure 2: Current limiting driver and current sensing circuit

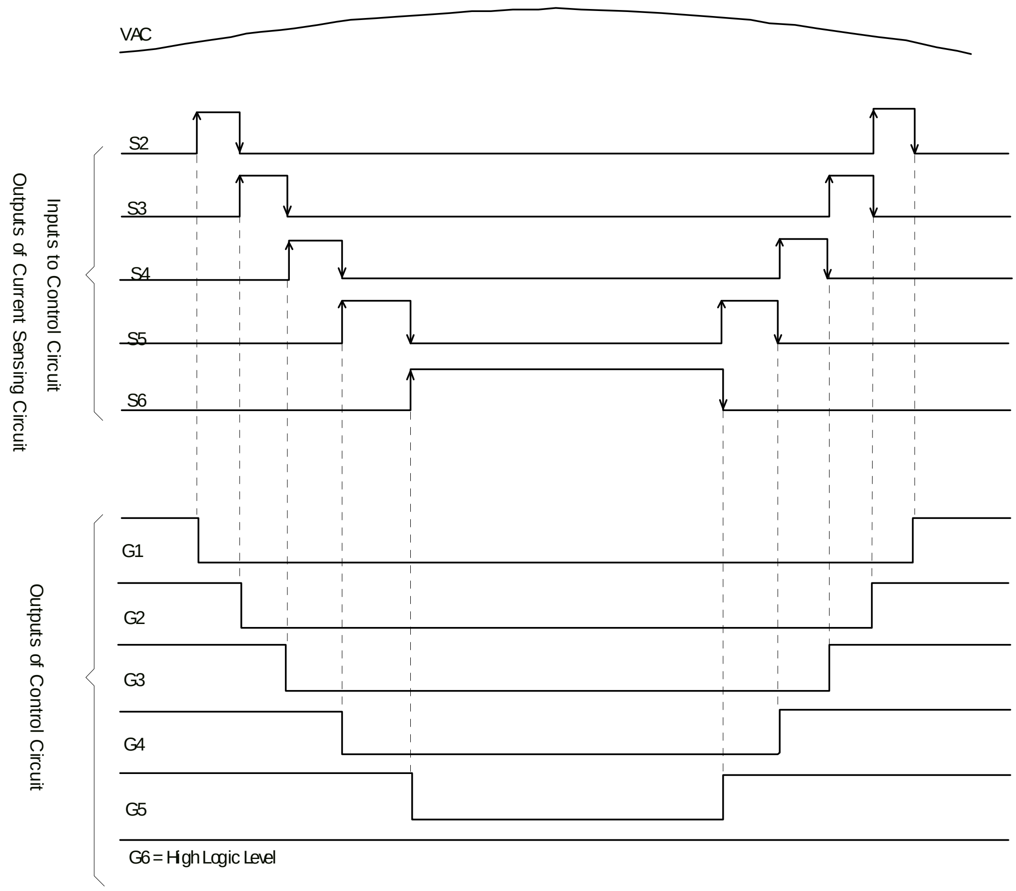


Figure 3: Timing diagram of logic control circuit for 220VAC application

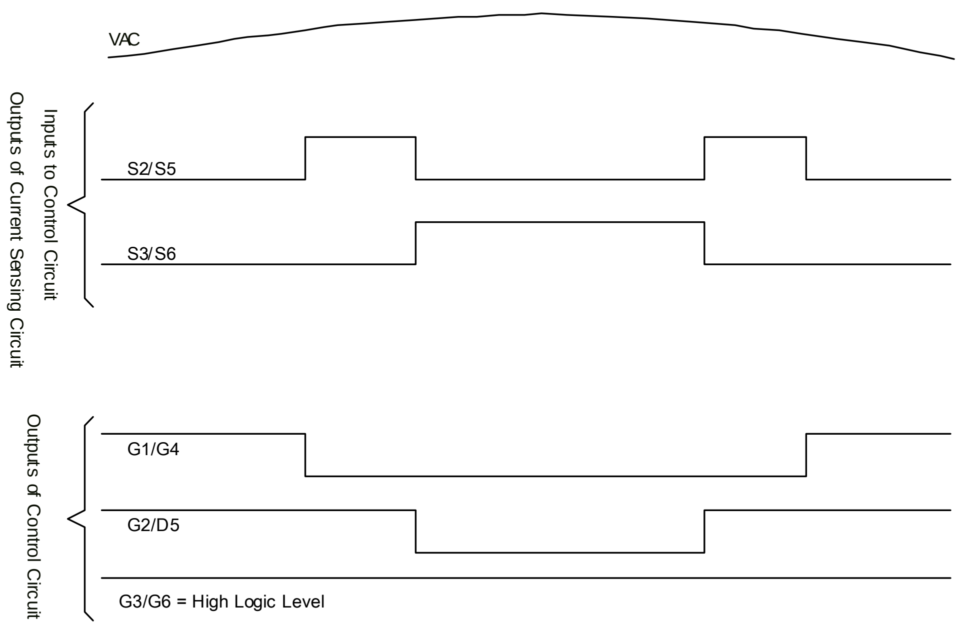


Figure 4: Timing diagram of logic control circuit for 110VAC application

Driving Current Setting

The external reference, VREF, applied to DR3062 is a reference for its internal regulator. The output voltage of the internal regulator is applied to the logic control circuit; that means, the gate voltage of the current driving MOSFET, G1 ~ G6, is proportional to VREF. Therefore, adjust the external reference voltage, VREF, will change the driving current as shown in Figure 5.

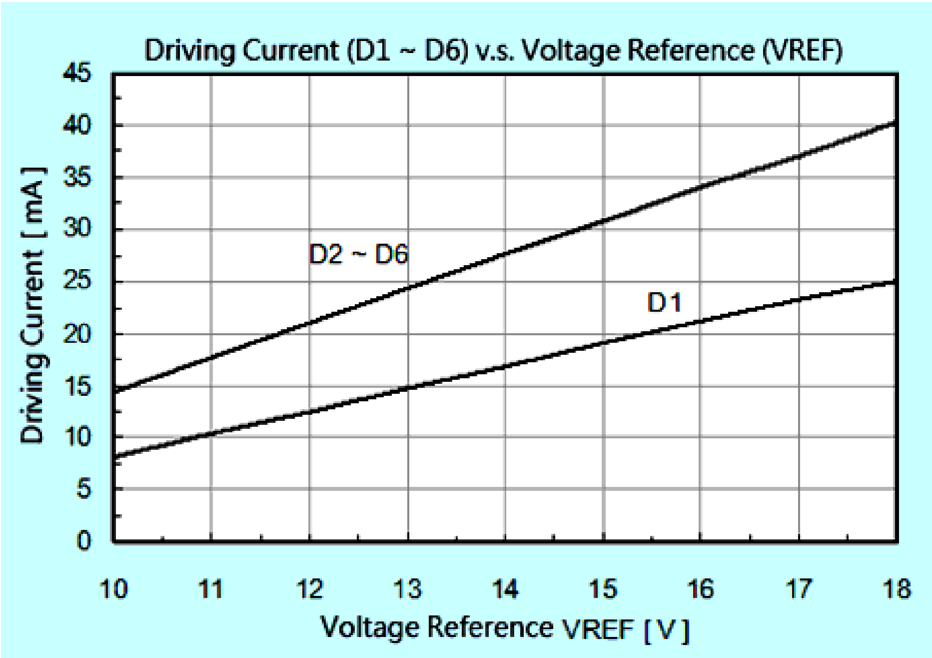


Figure 5: Driving currents, I(D1~D6), v.s. VREF with (V(D1..D6)=40VDC

As the VREF terminal will be pulled to GND level when surge protection circuit is activated, a resistor of 10KΩ must be connected between the VREF termianl and the externally applied voltage reference.

Current Limiting Driver

The current limiting driver can supply constant current as the applied voltage to the driver terminal is over 20VDC. Figure 6 shows the behavior of the current limiting driver D1, Figure 7 shows the behaviors of the current limiting drivers D2 to D6.

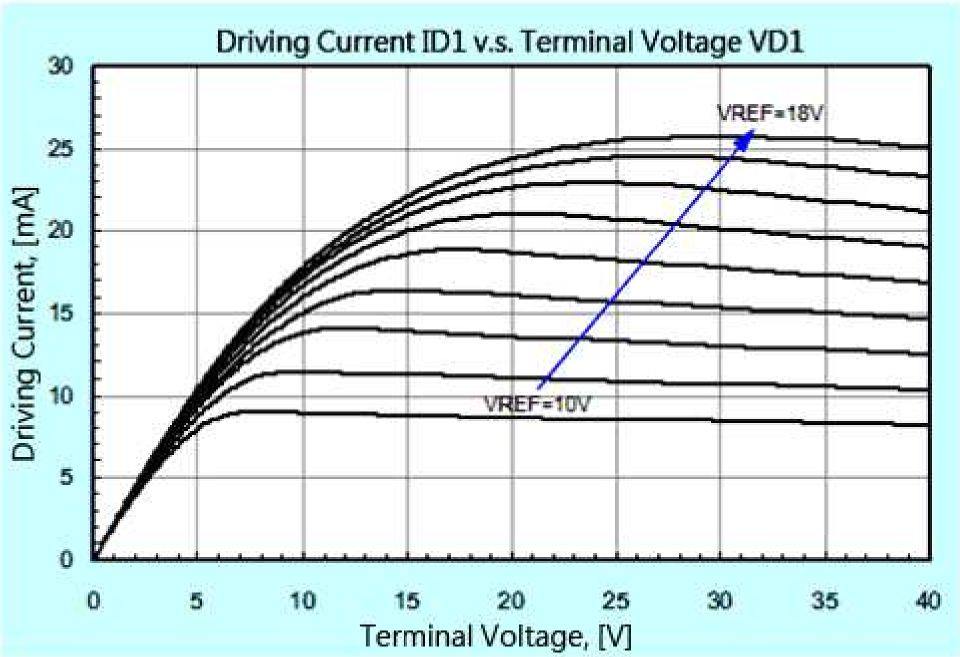


Figure 6: Driving current v.s. driver terminal voltage (I(D1) v.s. V(D1))

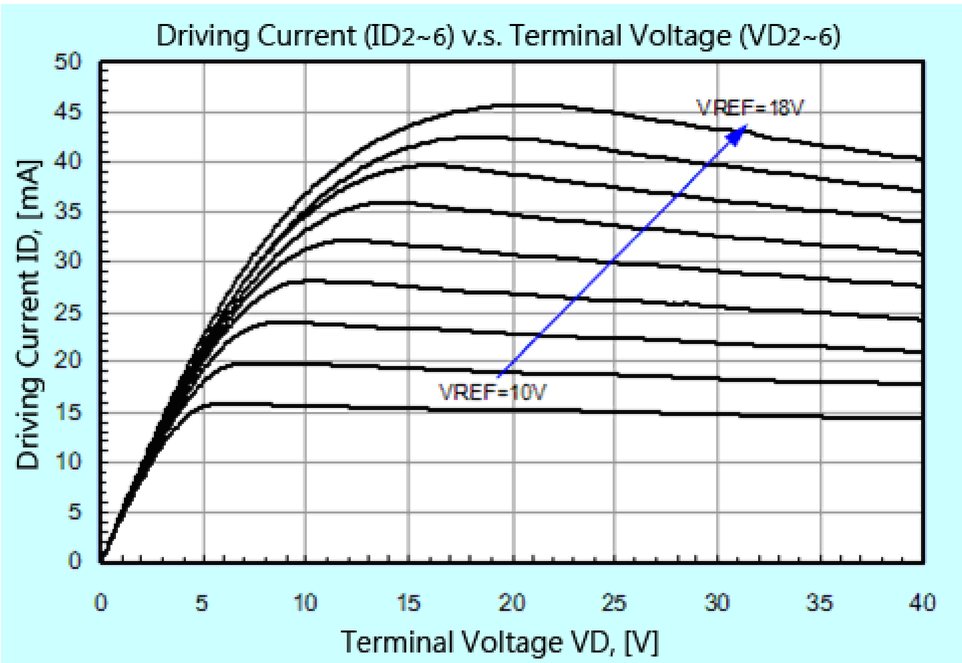


Figure 7: Driving current v.s. driver terminal voltage (I(D2..D6) v.s. V(D2..6))

To ensure DR3062's reliability, the current limiting driver is purposely desgianged to have negative temperature coefficient to prevent "thermal-run-away". With negative temperature coefficient, the driver will lower the current when the driver's temperature rises; Lowering the driving current will, in turn, bring down the temperature; a safe thermal equilibrium is reached thus.

Supply current

The DC supply current to DR3062, I_{DC}, is proportional to the external reference voltage as shown in Figure 8. For 110VAC/220VAC application, the power consumption is about 12mW/24mW with V_{REF} being set at 18VDC.

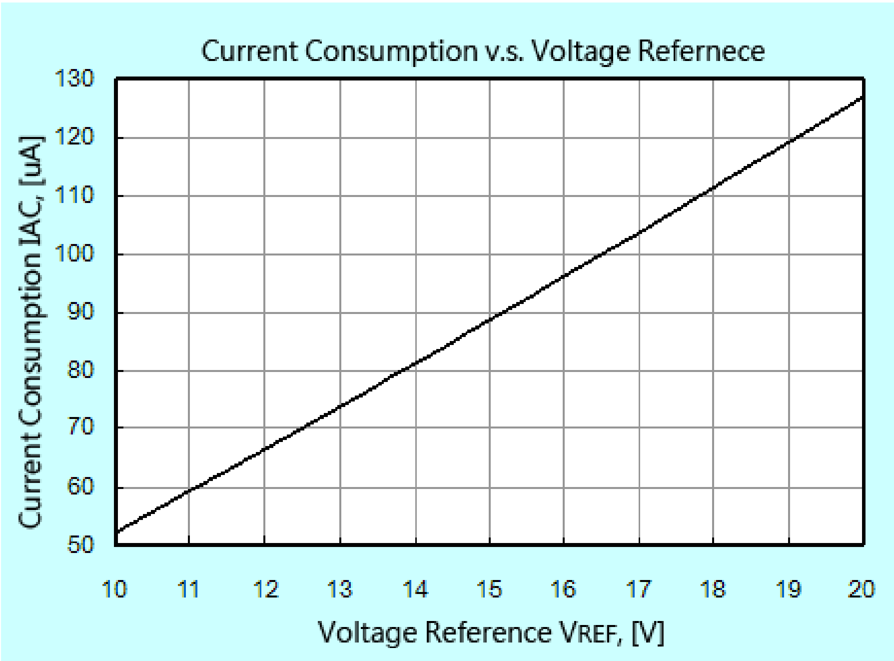


Figure 8: DC supply current v.s. reference voltage (I_{DC}(VAC) v.s. V_{REF})

High Voltage LED Assembly

The high voltage LED consists of several low voltage LEDs in serial as shown below:

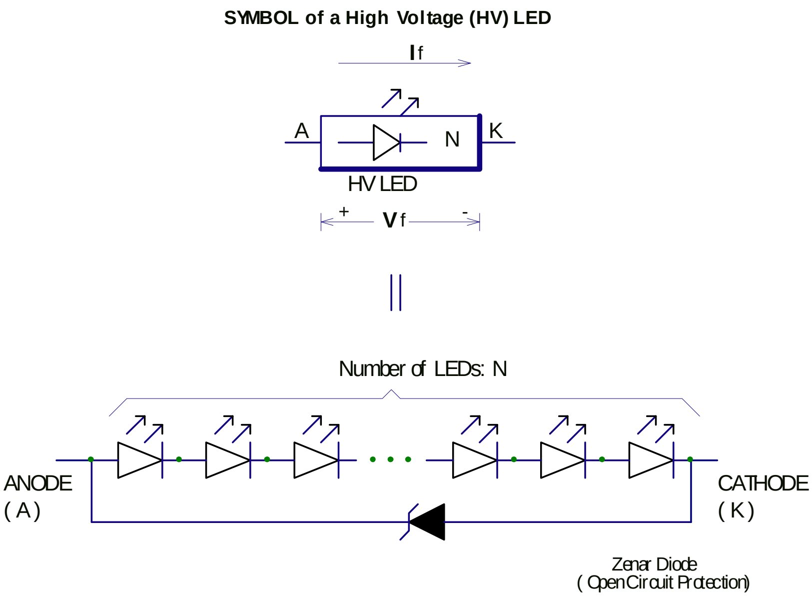
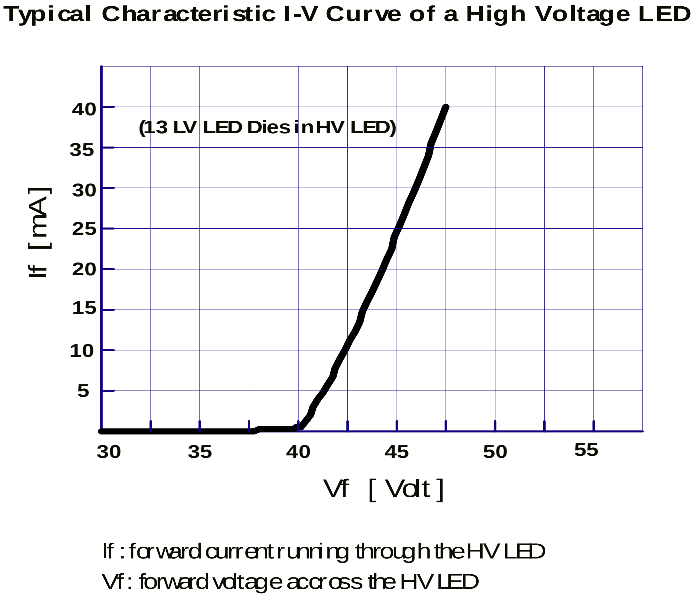


Figure 9: Assembly diagram of a high voltage LED

Since a high voltage LED is made by serially connecting several low voltage LEDs, the characteristics of the low voltage LED should be obtained first; the most important characteristics is the I-V curve. With the I-V curve, designers can calculate the number of low voltage LEDs required for building a high voltage LED. The I-V curve of a typical high voltage LED consisting of 13 low voltage LEDs is shown in Figure 3, the forward voltage is 47.5V when operating at 40mA.



Fiure 10: IV Curve of a Typical High Voltage LED

How to calculate the number of lowe voltage LEDs (220VAC)

Design Parameters required:

- Rated input voltage: Vrated (unit: Vrms)
- Operating forward current: If (Uint: mA , considering main driving current I6 only)
- Forward voltage of LV LED at If: Vf (Unit: Vdc)

Total of LV LEDs required: Ntotal = Vrated * 1.414 * 0.9 / Vf (rounded to integer)

Case (1): Use 6 HV LEDs
The number of LV LEDs in each HV LED : Nhvled = Ntotal / 6 (rounded to integer)

Case (2): Use 7 HV LEDs (2 HV LEDs for the 1st driver)
The number of LV LEDs in each HV LED: Nhvled = Ntotal / 7 (rounded to integer)

Case (3): Use 12HV LEDs (2 HV LEDs for each driver)
The number of LV LEDS in each HV LED: Nhvled = Ntotal / 12 (rounded to integer)

Case (4): Use 13HV LEDs (3 HV LEDs for 1st driver, and two for the others)
The number of LV LEDs in each HV LED: Nhvled = Ntotal / 13 (rounded to integer)

Example :

The rated input power is 220VAC; the main driving current is set at 50mA. Assume that the forward volatge of LV LED is 3.65V when operating at 50mA, then the minimal number of LV LEDs required is:

Ntotal = 220V * 1.414*0.9 / 3.65 = 77 (rounded to integer)

Case (1): Nhvled = 77 / 6 = 13 (rounded to integer)

Case (2): Nhvled = 77 / 7= 11 (rounded to integer)

Case (3): Nhvled = 77 / 12 = 6 (rounded to integer)

Case (4): Nhvled = 77 / 13= 6 (rounded to integer)

How to calculate the number of lowe voltage LEDs (110VAC)

Design Parameters required:

- Rated input voltage: Vrated (unit: Vrms)
- Operating forward current: If (Uint: mA , considering main driving current I6 only)
- Forward voltage of LV LED at If: Vf (Unit: Vdc)

Total of LV LEDs required: Ntotal = 2*Vrated * 1.414 * 0.9 / Vf (rounded to even integer)

Case (1): Use 6 HV LEDs
The number of LV LEDs in each HV LED : Nhvled = Ntotal / 6 (rounded to integer)

Case (2): Use 8 HV LEDs (2 HV LEDs for the 1st driver)
The number of LV LEDs in each HV LED: Nhvled = Ntotal / 8 (rounded to integer)

Case (3): Use 12HV LEDs (2 HV LEDs for each driver)
The number of LV LEDS in each HV LED: Nhvled = Ntotal / 12 (rounded to integer)

Case (4): Use 14HV LEDs (3 HV LEDs for 1st driver, and two for the others)
The number of LV LEDs in each HV LED: Nhvled = Ntotal / 14 (rounded to integer)

Example :

The rated input power is 110VAC; the main driving current is set at 50mA. Assume that the forward volatge of LV LED is 3.65V when operating at 50mA, then the minimal number of LV LEDs required is:

Ntotal = 2*110V * 1.414*0.9 / 3.65 = 78 (rounded to even integer)

Case (1): Nhvled = 78 / 6 = 13 (rounded to integer)

Case (2): Nhvled = 78 / 8= 10 (rounded to integer)

Case (3): Nhvled = 78 / 12 = 7 (rounded to integer)

Case (4): Nhvled = 78 / 14= 6 (rounded to integer)

Heat Dissipation

With the negative temperature coefficient of the six current drivers, DR3062C can operate in the condition of 125℃. However, a good heat dissipation design will not only reduce the accumulated heat but aso increase the LED's efficacy and life. The exposed thermal pad on the buttom of the package, desinged for maximizing thermal relief, must physically contact a heat sink on the PCB. The exposed thermal pad is electrically connected to GND terminal, therefore, it is not allowed to electrically connect to the metal housing.

The influence of Input Power Variation on Luminance

Although the DR3062 can drive the HV LEDs in the sense of constant current, the voltage variation of input power will affect the duty factor of each driving current, resulting in a variation on the light intensity. According to the field test results, when the voltage of input power drops 10% below rated voltage, the light intensity also drops 10%; when the voltage of input power increases 10% above rated voltage, the light intensity increases less than 5%. Both incandescent lamp or fluorescent lamp have the same phenominum. For human beings, 15% brightness change will not be noticed. Because DR3062 is not designed to work in constant power manner, when the electrical power drops, the current consumption will not increase. If the design of a large lighting system is based on constant power, the current will increase dramatically when the electricity is not able to supply enough power; in this case, the constant-power design will further deteriorate the power supply quality.

Light switch with Neon Indicator

If a light switch with neon indicator is used, the neon indicator itself is a leakage path when the switch is turned off. In this case, the LED lamp might not be completely turned off. In this case, a 47KΩ resisor with 0805 package must be connected between the 1st driver terminal and VAC terminal to lower the voltage across the high voltage LED; alternatively, an X1 capacitor of 0.11uF is placed before the bridge rectifier to lower the voltage across the lamp. For details, please refer to application circuits.

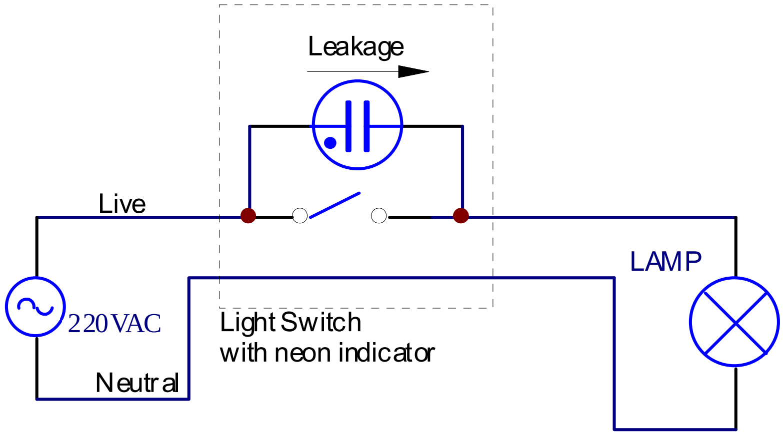
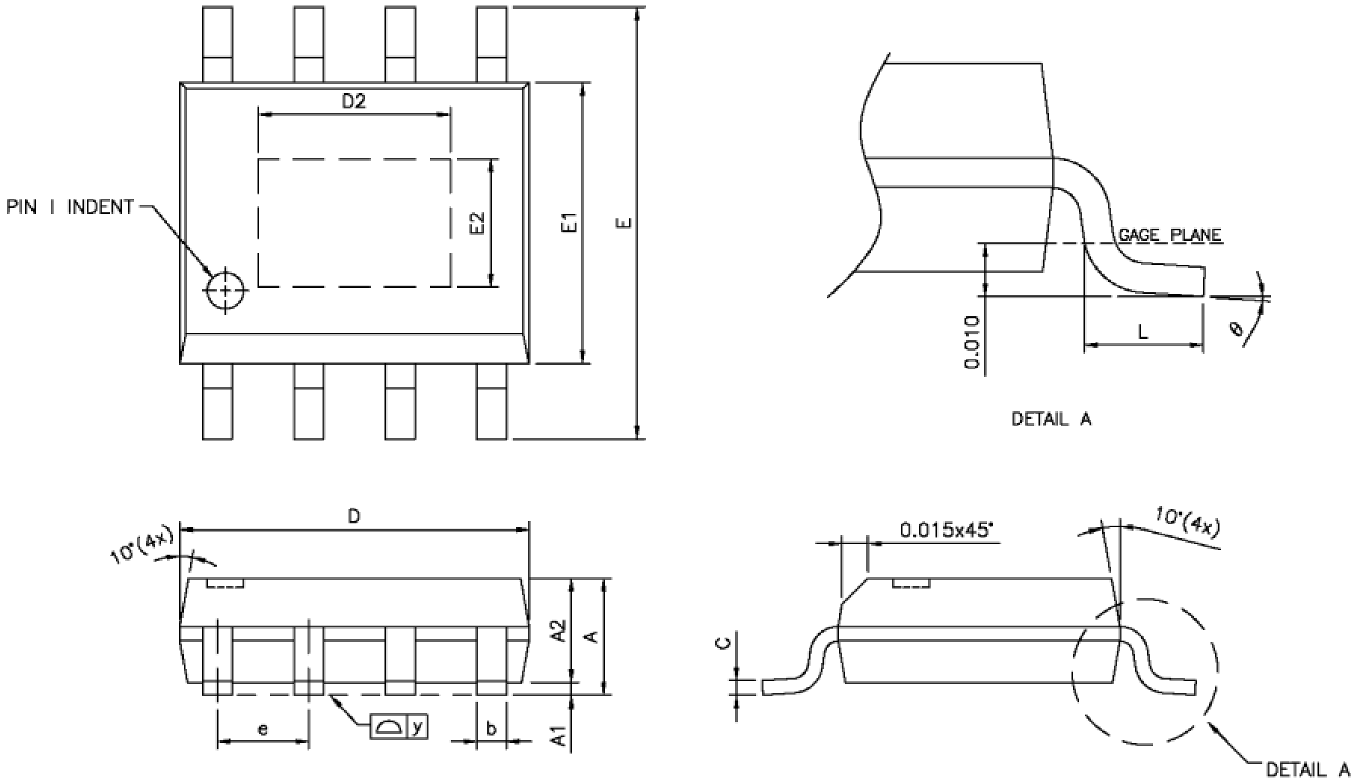


Figure 11: Light Switch with neon indicator

Conformal Coating

A conformal coating with the thickness of 30 ~120um should be applied to the printed wiring assembly in order to increase the air clearance and creepage distance between any two high voltage leads of DR3062. Conformal coating material is applied to electronic circuitry to act as protection against moisture, dust, chemicals, and temperature extremes that, if uncoated (non-protected), could result in damage or failure of the electronics to function. When electronics must withstand harsh environments and added protection is necessary, most circuit board assembly houses coat assemblies with a layer of transparent conformal coating rather than potting. The most common standards for conformal coating are IPC A-610 and IPC-CC-830. These standards list indications of good and bad coverage and describe various failure mechanisms such as dewetting and orange peel.

Mechanical dimensions of SOP8 Package



EXPOSED PAD DIMENSION (inch)						
PAD SIZE / OPTION	D2			E2		
	MIN	NOM	MAX	MIN	NOM	MAX
A.)95x130mil	0.105	——	——	0.070	——	——
⚠ B.)90x90mil	0.065	——	——	0.065	——	——

NOTE :

1. CONTROLLING DIMENSION : INCH
2. LEAD FRAME MATERIAL : COPPER 194
3. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, TIE BAR BURRS AND GATE BURRS. MOLD FLASH, TIE BAR BURRS AND GATE BURRS SHALL NOT EXCEED 0.006"[0.15mm] PER END. DIMENSION "E1" DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010"[0.25mm] PER SIDE.
4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.003"[0.08mm] TOTAL IN EXCESS OF THE "b" DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD TO BE 0.0028"[0.07mm]
5. TOLERANCE : ±0.010"[0.25mm] UNLESS OTHERWISE SPECIFIED.
6. OTHERWISE DIMENSION FOLLOW ACCEPTABLE SPEC.

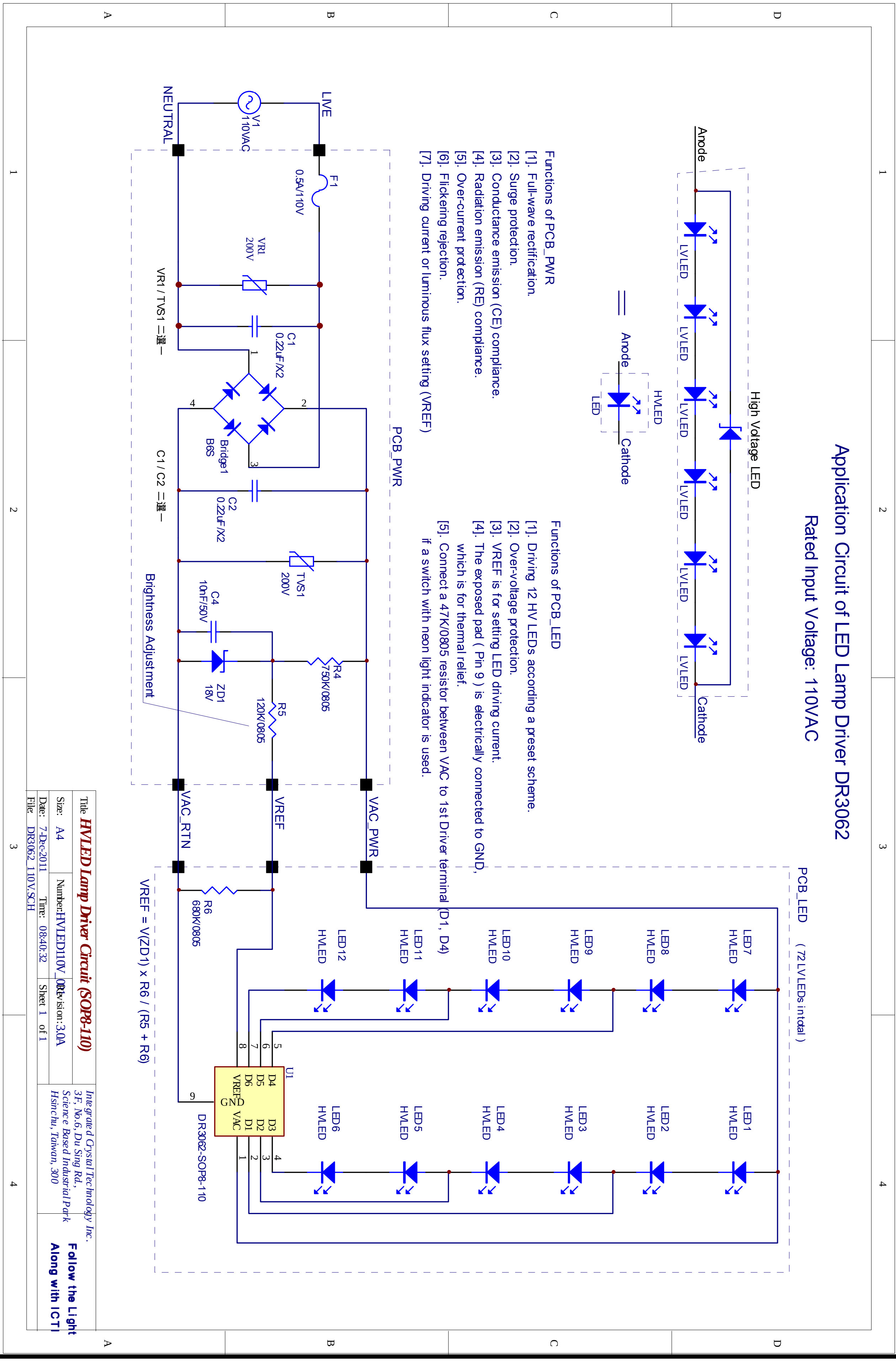
SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.47	1.60	1.73	0.058	0.063	0.068
A1	0.10	——	0.25	0.004	——	0.010
A2	——	1.45	——	——	0.057	——
b	0.33	0.41	0.51	0.013	0.016	0.020
C	0.19	0.20	0.25	0.0075	0.008	0.0098
D	4.80	4.85	4.95	0.189	0.191	0.195
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e	——	1.27	——	——	0.050	——
L	0.40	0.71	1.27	0.016	0.028	0.050
y	——	——	0.076	——	——	0.003
θ	0°	——	8°	0°	——	8°

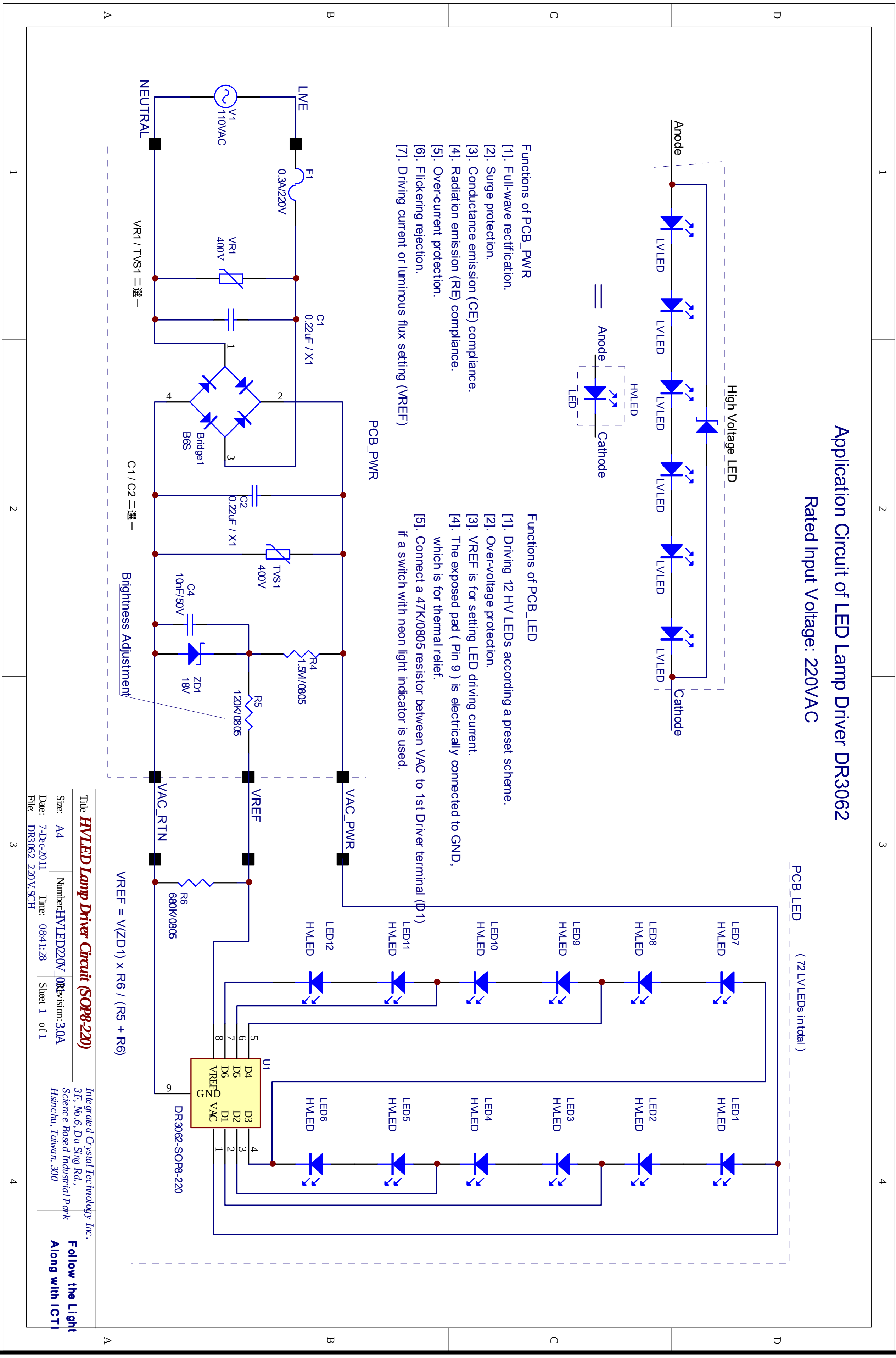
Appendix: Application circuit

110VAC application (DR3062-SOP8-110)

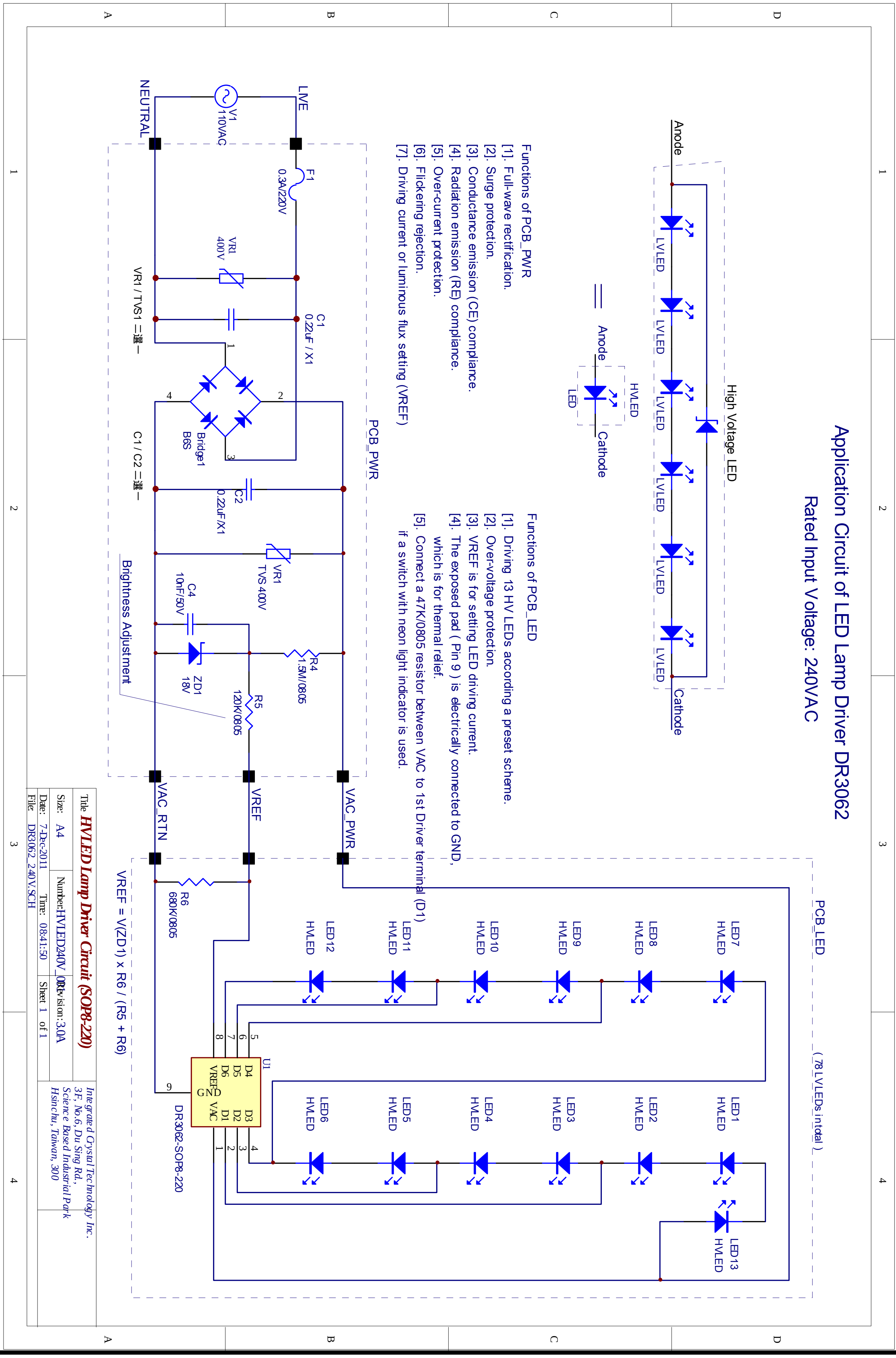
220VAC application (DR3062-SOP8-220)

240VAC application (DR3062-SOP8-220)


Application Circuit of LED Lamp Driver DR3062
Rated Input Voltage: 110VAC
High Voltage LED
Anode
Cathode
LVLED
HVLED
LED
Functions of PCB_PWR
[1]. Full-wave rectification.
[2]. Surge protection.
[3]. Conductance emission (CE) compliance.
[4]. Radiation emission (RE) compliance.
[5]. Over-current protection.
[6]. Flickering rejection.
[7]. Driving current or luminous flux setting (VREF)
Functions of PCB_LED
[1]. Driving 12 HV LEDs according a preset scheme.
[2]. Over-voltage protection.
[3]. VREF is for setting LED driving current.
[4]. The exposed pad (Pin 9) is electrically connected to GND, which is for thermal relief.
[5]. Connect a 47K/0805 resistor between VAC to 1st Driver terminal (D1, D4) if a switch with neon light indicator is used.
LIVE
NEUTRAL
V1 110VAC
F1 0.5A/110V
VR1 200V
C1 0.22uF/X2
Bridge1 B6S
C2 0.22uF/X2
TVS1 200V
C4 10nF/50V
ZD1 18V
R4 750K/0805
R5 120K/0805
VR1 / TVS1 二選一
C1 / C2 二選一
Brightness Adjustment
PCB_PWR
VAC_PWR
VREF
VAC_RTN
PCB_LED (72 LV LEDs in total)
R6 680K/0805
VREF = V(ZD1) x R6 / (R5 + R6)
LED1 HVLED
LED2 HVLED
LED3 HVLED
LED4 HVLED
LED5 HVLED
LED6 HVLED
LED7 HVLED
LED8 HVLED
LED9 HVLED
LED10 HVLED
LED11 HVLED
LED12 HVLED
U1
D4 D5 D6 VREF GND VAC D1 D2 D3
DR3062-SOP8-110
Title HVLED Lamp Driver Circuit (SOP8-110)
Size: A4
Number: HVLED110V_001
Revision: 3.0A
Date: 7-Dec-2011
Time: 08:40:32
Sheet 1 of 1
File: DR3062_110V.SCH
Integrated Crystal Technology Inc.
3F, No.6, Du Sing Rd.,
Science Based Industrial Park
Hsinchu, Taiwan, 300
Follow the Light
Along with ICTI



Application Circuit of LED Lamp Driver DR3062
Rated Input Voltage: 220VAC
Functions of PCB_PWR
[1]. Full-wave rectification.
[2]. Surge protection.
[3]. Conductance emission (CE) compliance.
[4]. Radiation emission (RE) compliance.
[5]. Over-current protection.
[6]. Flickering rejection.
[7]. Driving current or luminous flux setting (VREF)
Functions of PCB_LED
[1]. Driving 12 HV LEDs according a preset scheme.
[2]. Over-voltage protection.
[3]. VREF is for setting LED driving current.
[4]. The exposed pad (Pin 9) is electrically connected to GND, which is for thermal relief.
[5]. Connect a 47K/0805 resistor between VAC to 1st Driver terminal (D1) if a switch with neon light indicator is used.
High Voltage LED
Anode
Cathode
LVLED
HVLED
LED
PCB_PWR
PCB_LED
(72 LVLEDs in total)
LIVE
NEUTRAL
V1 110VAC
F1 0.3A/220V
VR1 400V
C1 0.22uF / X1
C2 0.22uF / X1
Bridge1 B6S
TVS1 400V
C4 10nF/50V
ZD1 18V
R4 1.5M/0805
R5 120K/0805
R6 680K/0805
Brightness Adjustment
VAC_RTN
VREF
VAC_PWR
VREF = V(ZD1) x R6 / (R5 + R6)
U1
DR3062-SOP8-220
LED1 LED2 LED3 LED4 LED5 LED6 LED7 LED8 LED9 LED10 LED11 LED12
Title HVLED Lamp Driver Circuit (SOP8-220)
Size: A4
Number: HVLED220V_001
Revision: 3.0A
Date: 7-Dec-2011
Time: 08:41:28
Sheet 1 of 1
File: DR3062_220V.SCH
Integrated Crystal Technology Inc.
3F, No.6, Du Sing Rd., Science Based Industrial Park Hsinchu, Taiwan, 300
Follow the Light
Along with ICTI


Application Circuit of LED Lamp Driver DR3062
Rated Input Voltage: 240VAC
High Voltage LED
Anode
Cathode
LVLED
HVLED
LED
=
Functions of PCB_PWR
[1]. Full-wave rectification.
[2]. Surge protection.
[3]. Conductance emission (CE) compliance.
[4]. Radiation emission (RE) compliance.
[5]. Over-current protection.
[6]. Flickering rejection.
[7]. Driving current or luminous flux setting (VREF)
Functions of PCB_LED
[1]. Driving 13 HV LEDs according a preset scheme.
[2]. Over-voltage protection.
[3]. VREF is for setting LED driving current.
[4]. The exposed pad (Pin 9) is electrically connected to GND, which is for thermal relief.
[5]. Connect a 47K/0805 resistor between VAC to 1st Driver terminal (D1) if a switch with neon light indicator is used.
PCB_PWR
LIVE
NEUTRAL
V1
110VAC
F1
0.3A/220V
VR1
400V
C1
0.22uF / X1
Bridge1
B6S
C2
0.22uF/X1
VR1 / TVS1 二選一
C1 / C2 二選一
VR1
TVS 400V
C4
10nF/50V
ZD1
18V
R4
1.5M/0805
R5
120K/0805
Brightness Adjustment
VAC_PWR
VREF
VAC_RTN
R6
680K/0805
VREF = V(ZD1) x R6 / (R5 + R6)
PCB_LED
(78 LVLEDs in total)
LED1 HVLED
LED2 HVLED
LED3 HVLED
LED4 HVLED
LED5 HVLED
LED6 HVLED
LED7 HVLED
LED8 HVLED
LED9 HVLED
LED10 HVLED
LED11 HVLED
LED12 HVLED
LED13 HVLED
U1
DR3062-SOP8-220
D4 D5 D6 VREF GND VAC D1 D2 D3
Title HVLED Lamp Driver Circuit (SOP8-220)
Size: A4
Number: HVLED240V_001
Revision: 3.0A
Date: 7-Dec-2011
Time: 08:41:50
Sheet 1 of 1
File: DR3062_240V.SCH
Integrated Crystal Technology Inc.
3F, No.6, Du Sing Rd.,
Science Based Industrial Park
Hsinchu, Taiwan, 300